

**What is claimed is:**

1. A surface-treated steel sheet with excellent corrosion resistance comprising:

a zinc-based plated steel sheet or an aluminum-based plated steel sheet;

a surface-treatment coating having coating thicknesses ranging from 0.01 to 1  $\mu\text{m}$ , and being formed by applying and drying a surface treatment coating composition which contains ingredients (a) through (c) described below on a surface of the plated steel sheet; and

a top coating having coating thicknesses ranging from 0.3 to 2  $\mu\text{m}$ , and being formed by applying and drying a coating composition for top coating, containing an (E) high molecular weight epoxy group-containing resin having number average molecular weights ranging from 6000 to 20000 on the surface-treatment coating:

(a) a water-epoxy resin dispersion which is prepared by dispersing in water a resin obtained by a reaction of: an (A) polyalkyleneglycol-modified epoxy resin derived from a reaction of polyalkyleneglycol having number average molecular weights ranging from 400 to 20000, a bisphenol type epoxy resin, an active hydrogen-containing compound, and a polyisocyanate compound; a (B) epoxy group-containing resin other than the (A) polyalkyleneglycol-modified epoxy resin; and an active hydrogen-containing compound in which a part or entire of the compound is structured by a (C) hydrazine derivative having active hydrogen;

(b) a silane coupling agent at amounts ranging from 1 to 300 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion; and

(c) phosphoric acid and/or a hexafluorometal acid at amounts ranging from 0.1 to 80 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion.

2. The surface-treated steel sheet according to claim 1, wherein the (C) hydrazine derivative containing active hydrogen is at least one compound selected from the group consisting of a pyrazole compound and a triazole compound, which compound has a ring structure of five-membered ring or six-membered ring, and has nitrogen atom in the ring structure.

3. The surface-treated steel sheet according to claim 1 or claim 2, wherein the surface treatment coating composition further contains a water-soluble phosphate at amounts ranging from 0.1 to 60 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion of the ingredient (a).

4. The surface-treated steel sheet according to any one of claims 1-3, wherein the surface treatment coating composition further contains a non-chromium based rust inhibitor at amounts ranging from 0.1 to 50 parts by mass of solid matter therein to 100 parts

by mass of the resin solid matter in the water-epoxy resin dispersion of the ingredient (a).

5. A surface-treated steel sheet with excellent corrosion resistance comprising:

a zinc-based plated steel sheet or an aluminum-based plated steel sheet;

a surface-treatment coating having coating thicknesses ranging from 0.01 to 1  $\mu\text{m}$ , and being formed by applying and drying a surface treatment coating composition which contains ingredients ( $\alpha$ ) through ( $\delta$ ) described below on a surface of the plated steel sheet; and

a top coating having coating thicknesses ranging from 0.3 to 2  $\mu\text{m}$ , and being formed by applying and drying a coating composition for top coating, containing an (E) high molecular weight epoxy group-containing resin having number average molecular weights ranging from 6000 to 20000 on the surface-treatment coating:

( $\alpha$ ) a water-epoxy resin dispersion which is prepared by dispersing in water a (Z) modified epoxy resin obtained by a reaction of a (W) epoxy group-containing resin, an (X) primary amine compound and/or secondary amine compound, and an active hydrogen-containing compound in which a part or entire of the compound is structured by a (Y) hydrazine derivative having active hydrogen;

( $\beta$ ) a water dispersed polyurethane resin at amounts of mass ratio of the resin solid matter in the water-epoxy resin dispersion to the resin solid matter in the water dispersed polyurethane

resine, [water-epoxy resin dispersion]/[water dispersed polyurethane resin], ranging from 95/5 to 5/95;

( $\gamma$ ) a silane coupling agent at amounts ranging from 1 to 300 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion; and

( $\delta$ ) phosphoric acid and/or a hexafluorometal acid at amounts ranging from 0.1 to 80 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion.

6. The surface-treated steel sheet according to claim 5, wherein the (Y) hydrazine derivative containing active hydrogen is at least one compound selected from the group consisting of a pyrazole compound and a triazole compound, which compound has a ring structure of five-membered ring or six-membered ring, and has nitrogen atom in the ring structure.

7. The surface-treated steel sheet according to claim 5 or claim 6, wherein the surface treatment coating composition further contains a water-soluble phosphate at amounts ranging from 0.1 to 60 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the sum of the water-epoxy resin dispersion of the ingredient ( $\alpha$ ) and the water dispersed polyurethane resin of the ingredient ( $\beta$ ).

8. The surface-treated steel sheet according to any one of claims

5-7, wherein the surface treatment coating composition further contains a non-chromium based rust inhibitor at amounts ranging from 0.1 to 50 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the sum of the water-epoxy resin dispersion of the ingredient ( $\alpha$ ) and the water dispersed polyurethane resin of the ingredient ( $\beta$ ).

9. The surface-treated steel sheet according to any one of claims 1-8, wherein the coating composition for top coating further contains a non-chromium based rust inhibitor at amounts ranging from 0.1 to 50 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the coating composition.

10. The surface-treated steel sheet according to any one of claims 1-9, wherein the surface treatment coating composition contains one or more compounds selected from the group consisting of (e1) through (e7) given below as the non-chromium based rust inhibitor:

(e1) silicon oxide

(e2) calcium and/or calcium compound

(e3) slightly-soluble phosphoric acid compound

(e4) molybdic acid compound

(e5) vanadium compound

(e6) organic compound containing S atom, being one or more compounds selected from the group consisting of triazole, thiol, thiaziazole, thiazole, and thiuram

(e7) organic compound containing N atom, being one or more compounds selected from the group consisting of hydrazide compound,

pyrazole compound, triazole compound, tetrazole compound, thiaziazole compound, and pyridazine compound.

11. The surface-treated steel sheet according to any one of claims 1-10, wherein the coating composition for top coating contains one or more compounds selected from the group consisting of (e1) through (e7) given below as the non-chromium based rust inhibitor:

(e1) silicon oxide

(e2) calcium and/or calcium compound

(e3) slightly-soluble phosphoric acid compound

(e4) molybdic acid compound

(e5) vanadium compound

(e6) organic compound containing S atom, being one or more compounds selected from the group consisting of triazole, thiol, thiaziazole, thiazole, and thiuram

(e7) organic compound containing N atom, being one or more compounds selected from the group consisting of hydrazide compound, pyrazole compound, triazole compound, tetrazole compound, thiaziazole compound, and pyridazine compound.

12. The surface-treated steel sheet according to any one of claims 1-11, wherein the coating composition for top coating further contains a curing agent having a group which crosslinks with hydroxyl group, at amounts ranging from 1 to 50 parts by mass of solid matter therein to 100 parts by mass of the solid matter in the (E) high molecular weight epoxy group-containing resin.

13. The surface-treated steel sheet according to claim 12, wherein the curing agent having a group crosslinking with hydroxyl group is an (F) amino resin which has one or more imino groups as an average within a single molecule thereof.

14. The surface-treated steel sheet according to claim 12, wherein the curing agent having a group crosslinking with hydroxyl group is a (G) polyisocyanate compound which has four or more isocyanate groups as an average within a single molecule thereof.

15. The surface-treated steel sheet according to claim 14, wherein the (G) polyisocyanate compound is the one in which at least some of the isocyanate groups in the polyisocyanate compound are blocked by a blocking agent.

16. The surface-treated steel sheet according to any one of claims 1-15, wherein the (E) high molecular weight epoxy group-containing resin in the coating composition for top coating is a modified epoxy group-containing resin which is modified by an (H) active hydrogen-containing compound in which a part or entire of the compound is structured by an (I) hydrazine derivative having active hydrogen.

17. The surface-treated steel sheet according to any one of claims 1-16, wherein the coating composition for top coating further contains a solid lubricant at amounts ranging from 1 to 30 parts by mass of solid matter therein to 100 parts by mass of the resin

solid matter in the coating composition.

18. A method for manufacturing surface-treated steel sheet with excellent corrosion resistance comprising the steps of:

applying a surface treatment coating composition which contains ingredients (a) through (c) described below onto a surface of a zinc-based plated steel sheet or an aluminum-based plated steel sheet, and then drying the applied surface treatment coating composition at ultimate sheet temperatures ranging from 30°C to 150°C, thus forming a surface-treatment coating having coating thicknesses ranging from 0.01 to 1  $\mu\text{m}$ ; and

forming a top coating having coating thicknesses ranging from 0.3 to 2  $\mu\text{m}$  on the surface-treatment coating by applying a coating composition for top coating containing an (E) high molecular weight epoxy group-containing resin having number average molecular weights ranging from 6000 to 20000, and then by drying the applied coating composition for top coating at ultimate sheet temperatures ranging from 30°C to 150°C:

(a) a water-epoxy resin dispersion which is prepared by dispersing in water a resin obtained by a reaction of: an (A) polyalkyleneglycol-modified epoxy resin derived from a reaction of polyalkyleneglycol having number average molecular weights ranging from 400 to 20000, a bisphenol type epoxy resin, an active hydrogen-containing compound, and a polyisocyanate compound; a (B) epoxy group-containing resin other than the (A) polyalkyleneglycol-modified epoxy resin; and an active hydrogen-containing compound in which a part or entire of the

compound is structured by a (C) hydrazine derivative having active hydrogen;

(b) a silane coupling agent at amounts ranging from 1 to 300 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion; and

(c) phosphoric acid and/or a hexafluorometal acid at amounts ranging from 0.1 to 80 parts by mass of solid matter thereof to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion.

19. A method for manufacturing surface-treated steel sheet with excellent corrosion resistance comprising the steps of:

applying a surface treatment coating composition which contains ingredients ( $\alpha$ ) through ( $\delta$ ) described below onto a surface of a zinc-based plated steel sheet or an aluminum-based plated steel sheet, and then drying the applied surface treatment coating composition at ultimate sheet temperatures ranging from 30°C to 150°C, thus forming a surface-treatment coating having coating thicknesses ranging from 0.01 to 1  $\mu\text{m}$ ; and

forming a top coating having coating thicknesses ranging from 0.3 to 2  $\mu\text{m}$  on the surface treatment coating by applying a coating composition for top coating containing an (E) high molecular weight epoxy group-containing resin having number average molecular weights ranging from 6000 to 20000, and then by drying the applied coating composition for top coating at ultimate sheet temperatures ranging from 30°C to 150°C:

( $\alpha$ ) a water-epoxy resin dispersion which is prepared by dispersing in water a (Z) modified epoxy resin obtained by a reaction of a (W) epoxy group-containing resin, an (X) primary amine compound and/or secondary amine compound, and an active hydrogen-containing compound in which a part or entire of the compound is structured by a (Y) hydrazine derivative having active hydrogen;

( $\beta$ ) a water dispersed polyurethane resin at amounts of mass ratio of the resin solid matter in the water-epoxy resin dispersion to the resin solid matter in the water dispersed polyurethane resin, [water-epoxy resin dispersion]/[water dispersed polyurethane resin], ranging from 95/5 to 5/95;

( $\gamma$ ) a silane coupling agent at amounts ranging from 1 to 300 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion; and

( $\delta$ ) phosphoric acid and/or hexafluorometal acid at amounts ranging from 0.1 to 80 parts by mass of solid matter therein to 100 parts by mass of the resin solid matter in the water-epoxy resin dispersion.